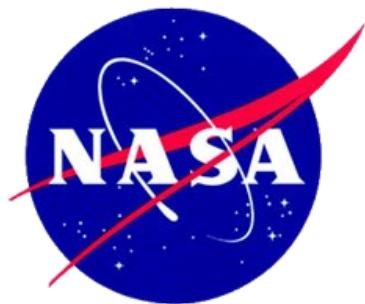


NASA Lighting Research, Test, & Analysis

Johnson Space Center
Human Systems Engineering & Development
Habitability & Human Factors
Lighting Team



The Habitability and Human Factors Branch, at Johnson Space Center, in Houston, TX, provides technical guidance for the development of spaceflight lighting requirements, verification of light system performance, analysis of integrated environmental lighting systems, and research of lighting-related human performance issues.

The Habitability & Human Factors Lighting Team maintains two physical facilities that are integrated to provide support. The Lighting Environment Test Facility (LETF) provides a controlled darkroom environment for physical verification of lighting systems with photometric and spectrographic measurement systems. The Graphics Research & Analysis Facility (GRAF) maintains the capability for computer-based analysis of operational lighting environments. The combined capabilities of the Lighting Team at Johnson Space Center have been used for a wide range of lighting-related issues.

Physical Assets

- Large (40 ft. x 120 ft.) dark room
- Specialty light sources capable of modeling orbital lighting conditions
- Standard illuminance and luminance meters
- Photo Research PR-670 spectroradiometer
- BWTEK spectral irradiance meter
- Minolta CM2700D Spectral Reflectance Meter
- Xrite MA-98 Multi-Angle Spectral Reflectance Meter
- Radiant Imaging high-resolution (3072 x 2048 pixel) imaging colorimeter
- Flicker test equipment

Specialty Software Assets

- Radiance Lighting Analysis Software
- Zemax Optics Studio Premium
- Creo / Pro-E
- Jack
- Rhino
- Matlab

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Example Projects from Johnson Space Center's Lighting Team

- Physical simulation of orbital light levels on targets for calibration of spacecraft external camera systems
- Development of requirements and verification statements for NASA spacecraft lighting standards for International Space Station (ISS), Orion, and Commercial Crew Vehicles
- Predictive colorimetric analysis of a lighting environment, using Matlab, for color matching error predictions of a critical airlock chemical screening test
- Wavelength specific flicker testing to document near-infrared interference from pulse width modulated light sources
- Software based predictive lighting analysis for human factors visibility safety assessments of spacecraft docking maneuvers, while considering trajectory, orbital lighting, and spacecraft artificial lighting conditions
- Determination of minimum candela requirements for new ISS solid state light fixture to meet task performance environmental illumination requirements via software predictive lighting model
- Validation of operational safety requirements for ISS emergency photo-luminescent indication system, via software based predictive lighting analysis
- Determination of orbital lighting conditions and luminance field on targets such as docking targets, heat shields, and parachute deployment covers, while considering orbital lighting environment and spacecraft

Customer Statements of Appreciation

Orion Spacecraft Program—Camera Imagery Team Support for the first test flight of the Orion capsule:

"The imaging was widely successful for EFT-1. I believe the GRAF modeling and LETF testing was extremely valuable. The settings used for imaging the Ogive as it was coming off – particularly the first ½ second was based on GRAF predictions and led to very good results. Post-Ogive-clearance imagery was mostly saturated, for reasons unrelated to any GRAF/LETF involvement. The SM Cameras viewing the SM fairing come off, as well as both of the SM Cameras viewing the heatshield, gathered good results. Their settings (aperture, exposure) were based on LETF testing. The forward bay cameras got very good results, which have led to what appears to be reliable photogrammetry measurements. The camera aperture, focus distance, frame rate and exposure settings were specified based on GRAF lighting predictions and LETF lighting tests." -Michael Rollins, Image Science and Analysis Group, JSC-X14 (JETS Contract)

International Space Station Solid State Lighting Assembly Project to upgrade lighting from fluorescent to LED:

"This is a letter of thanks for the support given to our program from you ... of the Johnson Space Center Graphics Research and Analysis Facility (GRAF) as well as the JSC Lighting Environment Test Facility (LETF). For more than seven years, members from these facilities have provided guidance on the practical application of both fluorescent and solid-state lighting for regulating ground and flight crew sleep/wake cycles and alertness in our human factors research at Thomas Jefferson University in Philadelphia. ... Our entire study team has deeply valued the guidance, input and data provided by the GRAF and LETF across diverse projects. In addition, other contributions include lighting analysis, NASA requirement reviews, and reviewing guidelines for design and installation of solid-state lighting in space application. ... We look forward to continue working with JSC's GRAF and LETF teams to improve lighting for the astronaut core and ground crew for current and future space missions." Dr. George Brainard, Ph.D. Director, Light Research Program, Professor of Neurology, Jefferson Medical College, Thomas Jefferson University.